

**VOLUNTARY CLEANUP COMPLETION REPORT  
FOR THE  
SANTA CRUZ MINE AREA  
RICO, COLORADO**

*Prepared for:*

**ARCO Environmental Remediation L.L.C.**  
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Anaconda, Montana 59711

*Prepared by:*

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Fort Collins, Colorado 80525

SEP 22 1999


September 17, 1999

## CERTIFICATION OF COMPLETION

ESA Consultants Inc. ("ESA") hereby certifies that the voluntary cleanup of the **Santa Cruz Mine Area, Rico, Colorado** has been fully and properly implemented in accordance with the cleanup plan approved on April 19, 1996 by the Colorado Department of Public Health and Environment.

ESA attests that it is fully qualified and has sufficient knowledge in this matter to so certify because ESA has been responsible for providing ARCO with both technical and permitting support since the beginning of the voluntary cleanup process. Specific activities completed by the ESA project team in support of voluntary cleanup plan development and implementation are summarized as follows:

1. Preparation of the approved voluntary cleanup plan application, which includes the ESA's statement of qualifications and the qualifications of individual contributors.
2. Design analysis, as necessary, to develop mine waste removal and containment approaches that provide adequate permanent protection of human health and the environment.
3. Development of detailed construction design drawings and specifications under the supervision of an ESA registered Professional Engineer.
4. Preparation of all permit applications required for voluntary cleanup construction.
5. Engineering services during construction: 1) inspections for conformance with design specifications, 2) development of design modifications to address special conditions encountered during construction, 3) fill compaction verification testing, and 4) confirmation soil sampling and analysis for verification of waste treatment (agricultural lime) application rates and waste removal.
6. Post-construction services: 1) assistance with the construction completion report, 2) surface water quality monitoring and reporting (2-year program), 3) annual site stabilization inspections, repair, and maintenance operations, 4) annual vegetation surveys, 5) annual reporting of stormwater permit compliance monitoring results and corrective actions taken, and 6) preparation of the approved construction stormwater permit inactivation request.

  
Edmund J. Schneider, P.G.  
Vice President  
ESA Consultants Inc.

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**Voluntary Cleanup Completion Report  
for the  
Santa Cruz Mine Area  
Rico, Colorado**

**1.0 INTRODUCTION**

**1.1 General**

This report provides, or incorporates by reference, evidence in support of the ARCO Environmental Remediation L.L.C. petition for a "No Further Action" determination, subsequent to completion of the voluntary cleanup of the Santa Cruz Mine Area in Rico, Colorado. The voluntary cleanup plan for the Santa Cruz Mine Area (Santa Cruz, Iron Clad, and Rico Boy mine site properties) has been developed, approved, and fully implemented in accordance with the Colorado Voluntary Cleanup and Redevelopment Act.

Information included in this report is summarized as follows:

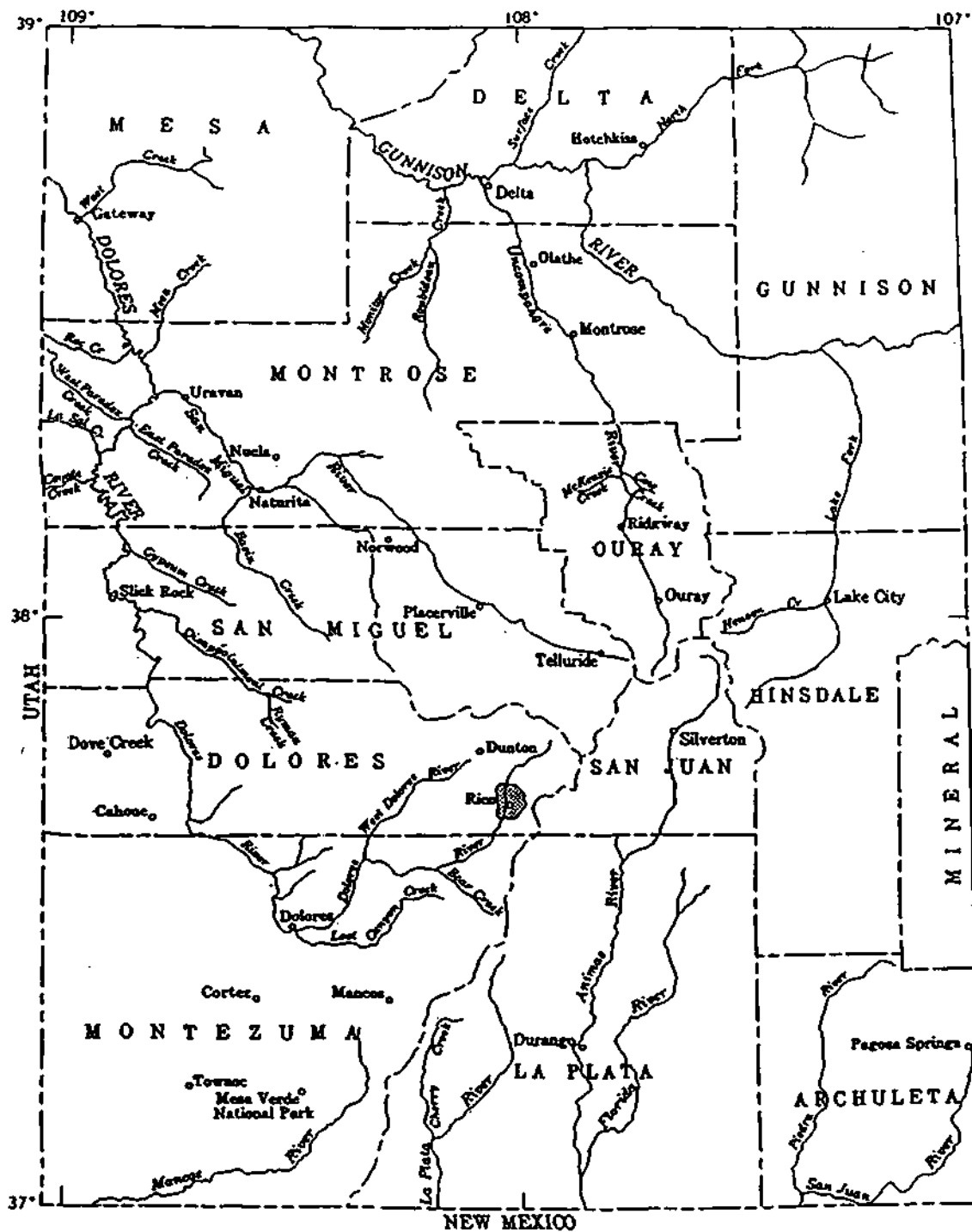
- References for a variety of voluntary cleanup plan implementation reports (e.g. construction completion, maintenance, and surface water quality monitoring program) previously submitted to the Colorado Department of Public Health and Environment ("Department").
- Summary of cleanup objectives, site conditions, issues, and implemented remedial measures.
- Summary of permits/approvals acquired for construction, compliance reports, and releases.
- Risk assessment based on the selected remedy for the designated land use of the site.

Figure 1-1 shows the location of Rico in southwestern Colorado. Figure 1-2 shows the location of the site within the Dolores River valley in the Town of Rico. Inactivation notice information for the Santa Cruz Mine Area mining stormwater discharge general permit certification is provided in the Appendix.

**1.2 Cleanup Plan Implementation Reports and Notices**

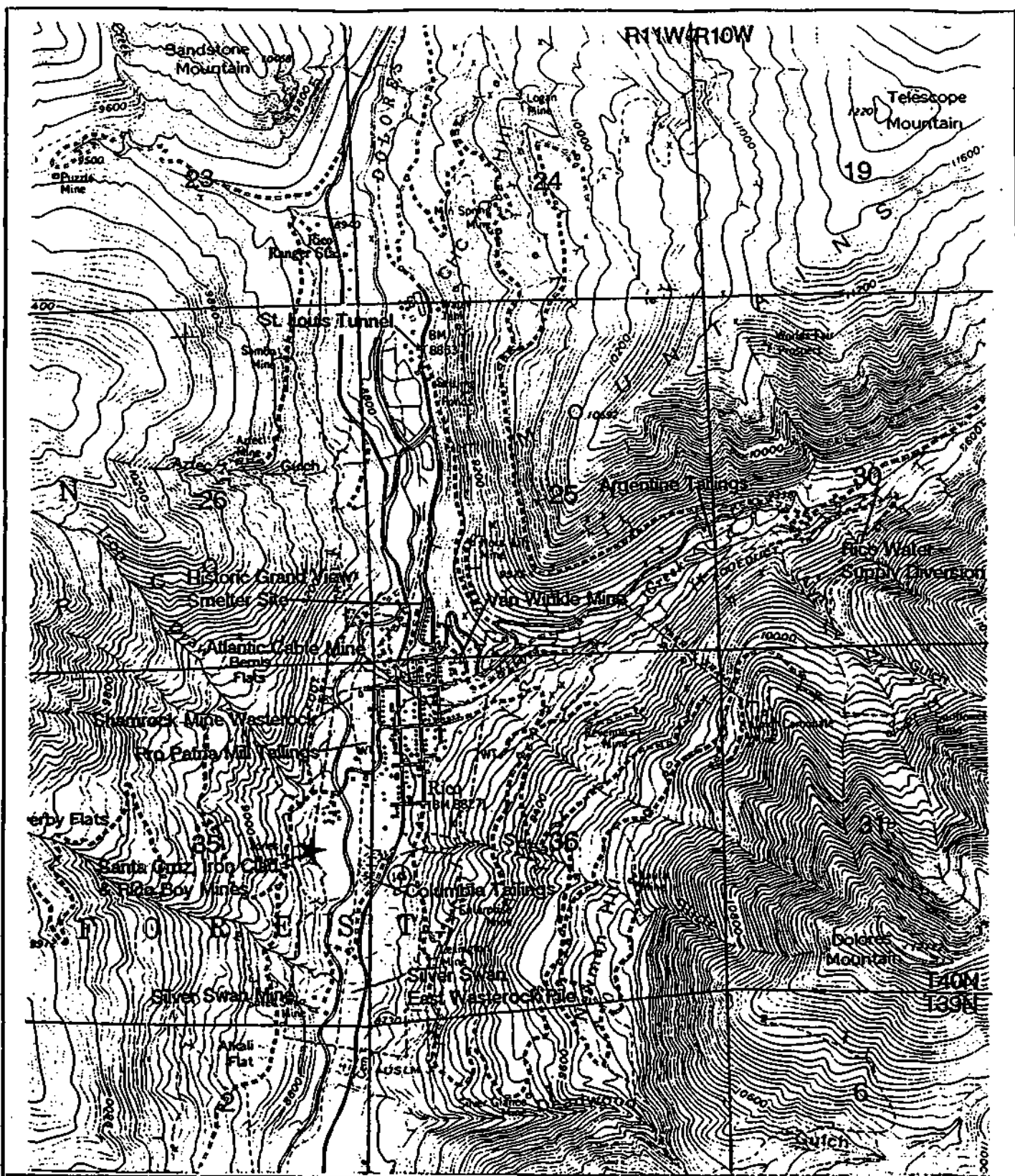
The following documents previously submitted to the Department and incorporated herein by reference provide substantial evidence that ARCO has complied with the voluntary cleanup plan, as approved by the Department on April 19, 1996.

*Voluntary Cleanup and Redevelopment Act Application for Santa Cruz Mine Area, Rico, Colorado. March 8, 1996. Atlantic Richfield Company, Los Angeles, Rico Properties, L.L.C., Frieda*



# RICO DISTRICT LOCATION MAP

FIGURE 1-1



0 1 MILE  
CONTOUR INTERVAL 40 FEET

SANTA CRUZ, IRON CLAD  
AND RICO BOY MINES  
SITE LOCATION MAP

FIGURE 1-2

Section lines added.

Base Map: USGS Rico Quadrangle, Colorado, 7.5 Minute Series.

Davis, Robert Hancock & Max Sitton, Laura Hannigan, Myron Jones, and Margaret Matzick.  
Submitted to Colorado Department of Public Health and Environment, Denver.

*Rico Mining Area Construction Completion Report. January 1997.* Atlantic Richfield Company, Los Angeles. Prepared by Anderson Engineering Co., Inc., Salt Lake City.

*Rico Site Remediation Project 1997 Maintenance Completion Report. October 1997.* ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

*Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Interim Report. October 1997.* ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

*Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Final Report. October 1998.* ARCO Environmental Remediation, L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

*Rico Site Remediation Project 1998 Maintenance Completion Report. November 1998.* ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

*Inactivation Notice for Mining Stormwater Discharge Permit Certification No. COR-040190, with attached Technical Memorandum - Reclamation Monitoring Results for the Santa Cruz Mine Area.* ARCO Application to the CDHPE Water Quality Control Division, signed October 1, 1998.

*Inactivation Approval- Stormwater Discharge Permit, effective February 2, 1999.* Letter to ARCO from the Water Quality Control Division, dated February 9, 1999.

### **1.3 Cleanup Goal and Objectives**

The goal of the approved voluntary cleanup plan for the historic mine area is to provide adequate protection of human health and the environment for the designated land use of the site. The essential objectives of the selected remedy addressed by the plan are to:

- Provide permanent solutions to eliminate or minimize, to the maximum extent practicable, the potential for release of mine waste constituents to surface and ground water systems.
- Prevent human ingestion of contaminated waste material in areas where inhalation of dust or direct contact could potentially pose an unacceptable health risk for the land use designated in the voluntary cleanup plan.
- Prevent any unnecessary disturbance of existing wetlands (which provide passive treatment of adit drainage) and the Dolores River during VCUP remedial activities.

## **2.0 SUMMARY OF PRE-CLEANUP SITE CONDITIONS AND ISSUES**

Major conditions and issues addressed by the cleanup plan for the Santa Cruz, Iron Clad, and Rico Boy mine sites include:

- Land ownership: Seven private property owners (portions of four patented claims and five land tracts) and San Juan National Forest land
- Area: approximately 5 acres with contributory drainage basin area of about 16 acres; area includes three mine adits (0.2 acres), a main waste rock pile (1.6 acres), and wetlands (with waste rock) and riparian area (3.2 acres) immediately east, northeast, and southeast of waste rock pile
- Mine waste volume and type of potential contaminants: 25,000 c.y. of historic mineralized mine waste containing heavy metals (predominantly iron, lead, and zinc) with additional heavy metals derived from historic passive mine adit drainage in contact with waste rock
- Pre-VCUP land use: Predominantly undeveloped inactive mine site; north end of site contains old mine facility buildings
- Future land use: Continued historic inactive mine site in Town of Rico's proposed Dolores River open space corridor with private property components (e.g., existing structures, access road, and parking area)
- Issues: 1) mine waste in 500-year flood plain; 2) incidental human contact with exposed waste; 3) water contact with waste from direct rainfall/snowmelt, runoff, adit drainage onto waste, and wetlands ponded against toe of waste pile; 4) one private property owner requested all waste be removed and adit drainage diverted away from owner's land (Winkfield Tract and Winkfield Tract West); and 5) river corridor aesthetics

## **3.0 SUMMARY OF IMPLEMENTED REMEDY**

### **3.1 Major Components of the Remedy**

Major components of the implemented remedy for mine waste material and reclamation of the mine sites include:

- Reclamation cover to eliminate direct human contact with mine waste considering the proposed future use of the property.
- Consolidation and stabilization of mine waste-left-in-place against earthquakes and wind and surface water erosion to prevent off-site dispersal of mine waste material.
- Runon, runoff, infiltration, and adit drainage controls to eliminate or minimize transport of soluble mine waste constituents to ground water and surface water receptors.



- Re-establishment of wetlands and flood plain plant communities in designated waste removal areas to provide vegetative habitat consistent with surrounding river corridor.
- Development of improved gravel access road and sedimentation pond.

### **3.2 Waste Removal and Consolidation**

A total area of 2.2 acres occupied by historic waste rock piles was reduced to 0.6 acres by waste removal and consolidation activities. Engineered mine waste consolidation measures were implemented to reduce the total area of land containing waste-left-in-place within the Dolores River corridor and completely remove waste materials as non-point sources of potential pollution from selected areas. Approximately 14,000 c.y. of waste material was removed from the site and consolidated at the Columbia tailings site, including about 5,000 c.y. of waste rock from the wetlands areas east and northeast of the main Santa Cruz waste rock pile. Mine waste material remaining at the Santa Cruz Mine Area was consolidated in the main waste rock pile west of the access road.

Verification of waste removal was accomplished through confirmation sampling and analysis of the underlying soil. Waste removal was considered complete, as described in the cleanup plan, after all waste material was confirmed by visual inspection and the soil sample analysis results indicated a zinc content of below or within the range of the natural background concentrations. Confirmation results are provided in the referenced construction completion report.

### **3.3 Hydrologic Controls**

Engineered hydrologic controls for runoff, infiltration, and flood protection have been constructed to permanently minimize water contact with waste material and achieve permanent containment of waste-left-in-place on the Santa Cruz Mine Area properties.

**Waste pile surface re-configuration and reclamation cover.** The reclaimed consolidated waste rock pile was graded, compacted, and protected by a reclamation cover for erosion protection and infiltration control. Compaction depth was 12 inches. The small area of top surface was graded at 3 percent slope to the south to prevent ponding of surface water, safely shed site runoff, and reduce infiltration. Outslopes were graded to 3H:1V to increase slope stability against erosion and slumping. The reclamation cover is described below.

**Surface water and adit drainage diversion ditches.** A runoff control ditch about 200 feet in length was constructed between the reconfigured consolidated waste rock pile and the natural hillside west of the mine area. The runoff ditch was constructed of a combination of corrugated metal half pipe, a riprap lined stilling basin, and a full pipe beneath the relocated access road. The lined adit interception ditch, which captures drainage from the Rico Boy and Santa Cruz adits, conveys flow from north to south along the toe of the reshaped waste rock pile and prevents adit drainage from coming into contact with mine wastes. All the ditches are sized for the estimated peak runoff from a 100-year design storm event. The lined ditches, drop structures, and energy dissipation features have been placed to direct expected flows away from the reshaped waste rock pile and into a diked area of the wetlands for settling. An overflow spillway was constructed to allow water to pass from the diked sedimentation pond to the existing wetlands along the Dolores River corridor.

An un-lined surface ditch was constructed adjacent to the east side of the access road to collect and convey any potential seepage flowing from the access road embankment. The surface ditch terminates where an unnamed stream flows into the wetlands area south of the Santa Cruz Mine Area.

**Dolores River flood protection revetment.** Approximately 5,200 c.y. of mine waste rock material were removed from the Dolores River corridor area near the mines. The removal of waste rock cleared this material from contact with the Dolores River during 100 year flood events. The access road constructed along the east perimeter of the site will also serve as a dike to protect the remediated waste pile from flood flows and resultant erosion by the Dolores River.

### **3.4 Reclamation Cover**

A stabilizing reclamation cover was placed on the consolidated waste pile surface and all waste removal areas to provide permanent protection against wind and water erosion, infiltration control, protection against human and wildlife contact with waste materials, and enhancement of river corridor aesthetics. Components of the reclamation cover are summarized below.

**Lime amendment.** The top 12 inches of the waste pile has been treated with agricultural lime at an application rate ranging from 80 to 280 tons/acre to neutralize potential acid generation. No lime was required in the northeast removal area or on the access road. See construction completion report for application rate determination procedures and analysis results.

**Growth medium.** The Santa Cruz Mine Area waste pile is covered with 12 inches of clean borrow soil material. The waste removal area northeast of the waste rock pile was covered with approximately 12 inches of unprocessed borrow material. A local source of soil borrow material free of mine waste and debris was developed for this site. The borrow area was closed and revegetated after completion of site cleanup.

**Vegetation cover.** Two different seed mixtures of native grasses and forbes (general upland mix and slope stabilization mix) were used where appropriate to establish a protective vegetation cover on all disturbed areas. Fertilizer and hydromulch amendments were applied at the time of seeding to enhance plant establishment. Seed mixture and amendment application rates are provided in the construction completion report. The surface stability criterion proposed to the Department (Water Quality Control Division) under the stormwater discharge permit program was achievement of a minimum average cover of 50 percent combined plant and rock fragments.

Initial seeding of all disturbed areas designated for vegetative cover was completed during the second week of October 1996. Two annual revegetation inspections have been performed since construction completion, one in July 1997 and the other in September 1998 near the end of the growing season. Drought conditions in June 1997 prevented development of adequate plant cover during the first growing season at the Santa Cruz Mine Area. Consequently, the consolidated waste rock pile and the waste rock removal area northeast of the pile had to be reseeded, fertilized, and mulched in October 1997.

Quantitative results for the 1998 Santa Cruz Mine Area inspection indicate a stable surface has been achieved both on the reclaimed waste rock pile and the waste rock removal area northeast of the pile. On the reclaimed waste rock pile, cover by plants averaged about 32 percent (range of 16 to 46 percent) and the rock fragment cover averaged about 35 percent (range of 26 to 48 percent), resulting in a total average surface cover of about 67 percent. Within the waste rock removal area, cover by wetlands plants averaged about 46 percent (range of 32 to 57 percent) and the rock fragment cover averaged about 29 percent (range of 22 to 37 percent), resulting in a total average surface cover of about 75 percent.

#### **4.0 CONSTRUCTION/ACCESS PERMITS AND RELEASES**

##### **4.1 Permits**

The following listed permits were obtained by ARCO or the property owners as required to implement the approved voluntary cleanup plan. No other approvals were required to implement the plan.

- Stormwater Discharge Permit, CDPS Permit No. COR-040190; request for termination approved by the CDPHE and permit inactivated effective February 2, 1999.
- Corps of Engineers Nationwide General Permit No. 38, Cleanup of Hazardous and Toxic Wastes; expiration date was January 21, 1997.
- Industrial General Minimal Discharge Permit, CDPS Permit No. COG-600044; expiration date was 90 days after the effective date, May 31, 1996.
- U.S. Department of Agriculture, Forest Service Special-Use Permit, OMB No. 0596-0082; expiration date was June 15, 1997.

##### **4.2 Inactivation of Santa Cruz Mine Area Site Stormwater Discharge Permit**

As noted above, the stormwater discharge permit has been terminated based on the plant and rock fragment cover achieved, observed stability of the site surface, and the construction of other permanent hydrologic control structures. The Technical Memorandum describing the reclamation results for the site, as submitted with ARCO's request for termination of the stormwater discharge permit, and the Department's approval letter for permit inactivation are provided in the Appendix.

#### **5.0 RISK ASSESSMENT**

A key consideration in assessing risk associated with reclaimed consolidated mine waste left-in-place at the Santa Cruz Mine Area is the extent of human or environmental exposure when the property is used for the purpose identified in the approved voluntary cleanup plan (historic inactive mine site and open space corridor with existing structures, access road, and parking area). Completion of the voluntary cleanup has achieved reduction of risk to human health and the environment through the following:

- Removal of contaminated mine waste from wetlands and remediation of consolidated waste-left-in-place minimizes human and environmental exposure pathways.
- Stabilization of contaminated waste-left-in-place provides long-term minimization of human and environmental exposure pathways.
- Control of access and covering of exposed contaminated mine waste prevents direct human contact and minimizes human exposure pathways.

To assure the protection of human health, and to protect against environmental releases, effective closure of mine waste left-in-place has been achieved by waste consolidation and construction of several permanent and durable non-point source waste containment measures. For long-term effectiveness, emphasis was placed on "passive-care" approaches. These measures prevent direct human contact and provide long-term control of major contaminant migration pathways, including wind and surface water erosion, contaminated surface water runoff, and infiltration and seepage. Consequently, these measures eliminate or effectively reduce potential mine waste impacts to: 1) the beneficial uses of the waters of the State, 2) surrounding ecosystems, and 3) human health due to adsorption, ingestion, and/or inhalation of waste particles.

In addition, post-remediation monitoring and maintenance activities provide evidence that the properties, when used for the purpose identified in the cleanup plan, are protective of human health and the environment. Results of annual site stabilization inspections required under the Department's stormwater discharge permit program verified that the structural measures (such as flood protection, drainage diversion structures, and waste pile reconfiguration) are functioning as designed. In particular, the release of contaminated seepage and surface water runoff from the waste pile due to mine drainage has been effectively eliminated by the diversion of mine drainage away from the reclaimed waste pile.

Results of the annual inspections have also verified the stability of the surface cover. Proposed surface stability criterion for adequate plant and rock fragment cover protection of the reclaimed mine waste pile and waste removal areas were achieved by the end second growing season. The proposed stability criterion were approved by the Department (Water Quality Control Division) under the stormwater discharge permit program. As discussed above, achievement of adequate site stability has resulted in the inactivation of the stormwater discharge permit (see Appendix).

Pre- and post-remediation surface water quality monitoring results support evidence from the annual site stabilization inspections that the properties remain protective of human health and the environment. Monitoring results indicate that dissolved metals loads from the Santa Cruz Mine Area wetlands drainages do not impact beneficial uses of the Dolores River. Concentrations of selected dissolved metals in the Dolores River downstream of the Santa Cruz Mine Area continue to be consistently below cold water aquatic life standards.

In addition to the implemented remedial measures, site accessibility constraints further reduce potential human health risk by limiting the opportunity for direct human contact. The property remains inaccessible from the east by road and there are no pedestrian bridges across the river. An

improved gravel road on the west side of the valley provides access to the property from the north, however, a security gate controls vehicle access to the Santa Cruz Mine Area.

# **APPENDIX**

## **INACTIVATION STORMWATER DISCHARGE PERMIT**

# STATE OF COLORADO

Bill Owens, Governor  
Jane E. Norton, Executive Director

*Dedicated to protecting and improving the health and environment of the people of Colorado*

4300 Cherry Creek Dr. S.      Laboratory and Radiation Services Division  
Denver, Colorado 80246-1530      8100 Lowry Blvd.  
Phone (303) 692-2000      Denver CO 80220-6928  
Located in Glendale, Colorado      (303) 692-3090

<http://www.cdphe.state.co.us>



Colorado Department  
of Public Health  
and Environment

February 9, 1999

Atlantic Richfield Company  
ATTN: Chuck Stilwell  
307 E. Park Street, Suite 400  
Anaconda, MT 59711

Re: Inactivation - Stormwater Discharge Permit  
Santa Cruz Mine Area  
CDPS Permit No. COR-040190  
Dolores County

Dear Mr. Stilwell:

This office has reviewed your request for termination of the above-referenced permit. You have certified that your site has been stabilized. It is our opinion that this site does not require a stormwater discharge permit at this time. Your permit has been inactivated effective February 2, 1999.

We have prorated your annual fee pursuant to Section 6.16.(5)(A)(B) of the Permit Regulations which state:

"Once the Division proceeds to terminate a permit at the permittee's request, the prorated fee shall apply to the period of time the permit has been in effect including, but not exceeding, ninety (90) days from the date the permit termination request is received by the Division."

Your prorated amount for the 1998-1999 annual administrative fee is \$31.00 which covers the period July 1, 1998 through February 2, 1999. A refund in the amount of \$22.00 is being sent under separate cover.

If you have any questions about the fee or the inactivation, please contact me at (303) 692-3503.

Sincerely,

  
Charlene Montgomery  
Administrative Assistant  
WATER QUALITY CONTROL DIVISION

cc: Ed Schneider, ESA Consultants, 2637 Midpoint Dr., Ste. F, Ft. Collins, CO 80525-4415  
Local Health Department  
File

/cm

Colorado Department of Public Health & Environment  
Water Quality Control Division  
WQCD-P-B2  
4300 Cherry Creek Drive South  
Denver, Colorado 80246-1530

FOR AGENCY USE ONLY			
rec			
eff			
	Year	Month	Day

INACTIVATION NOTICE FOR

MINING STORMWATER DISCHARGE GENERAL PERMIT CERTIFICATION

Please print or type. Form must be filled out completely.

Certification Number: COR-04 0 1 9 0 Taxpayer ID or EIN 9 5 4 6 0 9 7 7 7  
-OR- COG-50 \_\_\_\_\_

Permittee (Company) Name: Atlantic Richfield Company

Permittee Address: ARCO Environmental Remediation  
444 South Flower Street  
Los Angeles, CA 90071 Phone No. ( 213 ) 486-8309

Mine/Facility Name: Santa Cruz Mine Area

Mining Site Address/Location: Picker Street extended, Rico

County: Dolores Contact Person: David M. Romero

Reason/justification for inactivation, and description of final site stabilization. (Attach any supporting documentation, such as proof of Mined Land Reclamation Board bond release): Voluntary remediation of this inactive mine waste pile was completed in October 1996. The attached Technical memoranda provides a summary of site characteristics, permanent remedial measures, reclamation results, and proposed success criteria revision for this site.

I certify under penalty of law that by the date of my signature below, all disturbed soils at the identified mining site have been finally stabilized; all temporary erosion and sediment control measures have been removed; all mining and equipment maintenance waste have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

I understand that by submitting this notice of inactivation, I am no longer authorized to discharge stormwater associated with mining activity by the general permit. I understand that discharging pollutants in stormwater associated with mining activities to the waters of the State of Colorado, where such discharges are not authorized by a CDPS permit, is unlawful under the Colorado Water Quality Control Act and the Clean Water Act.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C 1001 and 33 U.S.C. 1319.)

David Romero  
Signature of Permit Applicant (Legally Responsible Party)

10/1/98  
Date Signed

David M. Romero  
Name (printed)

Project Manager  
Title



## TECHNICAL MEMORANDUM

### RECLAMATION MONITORING RESULTS FOR THE SANTA CRUZ MINE AREA

Mining Stormwater Discharge General Permit Certification No.: COR-040190

September 16, 1998

#### Introduction

The historic, inactive Santa Cruz Mine Area is one of eight sites for which a Colorado Stormwater Discharge Permit was issued to Atlantic Richfield Company (ARCO) in association with five approved Voluntary Cleanup Plans (VCUPs) implemented in and near the Town of Rico under the Voluntary Cleanup and Redevelopment Act (VCRA). Environmental baseline field work associated with this project was begun in the Spring of 1995, followed by engineering and reclamation planning activities. Mine waste remediation construction work was completed in 1996. The first annual revegetation inspection was completed in July 1997, in a qualitative manner, and remedial measures recommended. Remedial measures were completed by October 1997. On September 9, 1998 the second annual revegetation inspection of this site was completed and quantitative vegetation cover data collected by Cedar Creek Associates, Inc.

The following paragraphs detail the overall characteristics of the Santa Cruz Mine Area and the results of the reclamation monitoring activities. The VCUP for this inactive mine waste site is described in the document *Voluntary Cleanup and Redevelopment Act Application for Santa Cruz Mine Area-Rico, Colorado* submitted in March 1996 to the Colorado Department of Public Health and Environment by Atlantic Richfield Company, et al. Remedial measures completed in 1997 are described in the document *Rico Site Remediation Project-1997 Maintenance Completion Report* submitted in October 1997 to ARCO Environmental Remediation L.L.C. by ESA Consultants, Inc.

#### General Site Characteristics and Site Remediation History

Original Disturbed Area : 2.5 acres with maximum sideslope angles of ~ 33 percent.

Original Material Composition: Pyritic waste rock material with low pH values (4.1 to 6.6) and Acid-Base Potential values (based on pyritic sulfur) of -37 tons of  $\text{CaCO}_3$ /1,000 tons of material. (Data taken from samples collected at the nearby Silver Swan Mine.)

1996 Remediation Summary: Consolidate outlying waste material (~ 6,000 cubic yards) with main waste pile and grade to engineering specifications; complete runoff and infiltration controls; amend top 12 inches of the waste surface with liming material; apply 12 inches of cover (borrow) soil (~1,200 cu. yds.); complete revegetation sequence (seedbed preparation, fertilization, seeding, mulching). All soil disturbing activities at the site were completed in September 1996.

Results of July 1997 Qualitative Monitoring: Revegetation success somewhat variable; no exposed waste material observed; surface stable except for isolated rilling; 5 to 35 percent vegetation cover estimated visually with 40 to 52 percent surficial coarse fragment cover.

Remedial Measures Recommended in 1997: Repair rills, fertilize, reseed, and mulch 1.2 acres of this site for which revegetation had not achieved the desired results at the end of the first growing season. The suggested remedial measures were completed in early October 1997.

### Results of 1998 Quantitative Monitoring

Revegetation monitoring at the Santa Cruz Mine Area was completed on September 8, 1998. As requested in the permit issued by the Colorado Department of Public Health and Environment, vegetation cover was measured to determine whether existing surficial conditions warrant the termination of this permit following two growing seasons. The revegetated area was divided into two reclaimed vegetation types based upon the species which had been planted and become established. These two types include the "wetland" type located on the nearly level graded area located in the northern portion of the disturbed area and the "upland" type located primarily on the graded waste pile slopes.

Cover for both vegetation types was measured using the "point-intercept" methodology. A laser-powered "Optical-Point Bar" developed by Cedar Creek Associates, Inc. was employed to gather the plant cover data. To complete data collection, five ten-meter transects were located in areas selected as representative of plant cover across this 2.5 acre site. Point-intercept data was collected at 0.1-meter intervals along each 10 meter transect such that 100 data points were collected per transect. Each data point could represent a bare ground, litter, rock (coarse fragments > 2 mm. in size) or vegetation "hit". Vegetation hits were recorded by species or genus where a plant could not be identified to species level. A total of 500 data points were collected at the Santa Cruz Mine Area. Statistical adequacy was not considered to be necessary as per the termination criteria specified in the stormwater permit issued.

Plant cover across the five transects traversed in the wetland vegetation type ranged from 32.0 to 57.0 percent with an average of 46.0 percent. The dominant species identified along the transects was *Agrostis alba* (redtop). Thirteen additional species were also found along the transects or were recorded as incidental species in this constructed wetland. These species included grass, forb, and shrub life-forms, represented by such species as *Carex rostrata* (beaked sedge), *Polygonum lapathifolium* (pale smartweed), and a *Salix* (willow). The percent of surface covered by rock fragments ranged from 22.0 to 37.0 percent with an average of 29.2 percent. Litter, bare ground, and open water averaged 3.6, 15.2, and 6.0 percent, respectively.

Across the five transects located in the upland vegetation type, plant cover ranged from 16.0 to 46.0 percent with an average of 32.0 percent. The dominant species identified along the transects were

*Bromus carinatus* (mountain brome) and *Agropyron dasystachyum* (thickspike wheatgrass). Twenty-three additional species were also found along the transects or were recorded as incidental species over the graded slopes. These species included grass, forb, and shrub life-forms, represented by such species as *Agropyron trachycaulum* (slender wheatgrass), *Penstemon strictus* (Rocky Mountain penstemon), and a *Rubus* (raspberry) species. The percent of surface covered by rock fragments ranged from 26.0 to 48.0 percent with an average of 35.2 percent. Litter, bare ground, and mulch cover averaged 7.6, 22.0, and 3.2 percent, respectively. It was also estimated that plant density was, at a minimum, 12 to 15 plants per sq. ft.

A copy of the plant cover data sheet completed in the field is included at the end of this Technical Memorandum, as are two representative photographs taken of the site during the field monitoring work.

### **Monitoring Data Summary and Proposed Vegetative Cover Criterion Revision**

Across five representative transects traversed in the upland vegetation type, surface cover by plants and rock fragments averaged 32.0 and 35.2 percent, respectively. Together, plants and rock fragments covered an average of 67.2 percent of the revegetated slopes of the Santa Cruz Mine Area. No rilling or gullyng was observed anywhere on this site during the 1998 monitoring field work. Minor sheet erosion is assumed to have occurred over the sloping portion of this site but there is no evidence of soil accumulation at the toe of the constructed slopes. In the constructed wetland, surface cover by plants and rock fragments averaged 46.0 and 29.2 percent, respectively. Plants and rock fragments combined covered an average of 75.2 percent of the revegetated surface. This site, presumably due to the high percent of surficial rock cover, and nearly level slopes in the case of the wetland area, exhibited little erosion in July 1997. This situation continues on to the end of the 1998 growing season resulting in a stable site surface supporting a healthy, developing plant community.

The stormwater permit termination criteria for vegetation cover requires that "vegetation has been established with an average cover or density, over the previously disturbed area, of a minimum of 40 percent vegetative cover or 70 percent of the vegetative cover of a similar undisturbed site, which ever is higher....." The permit goes on to say that the Division may " after consultation with the permittee and upon good cause being shown, revise the cover requirement on a case-by-case basis".

ARCO requests that the revegetation criteria applicable to this site be revised to reflect the surficial conditions at the site and the materials making up the seedbed, growth media, and substrate materials. To require that the average vegetation cover values be compared to the vegetative cover of an undisturbed similar site would not be appropriate. There are no similar undisturbed sites which are underlain at 12 inches with amended pyritic waste rock which is, in turn, underlain with graded pyritic waste rock as is the case for the graded slopes at this site. The only undisturbed upland herbaceous vegetation communities

known to exist in the area are mountain meadow communities which are typically underlain with more than 24 inches of quality soil material. Thus, a comparison with undisturbed meadow soils may not be appropriate.

A requirement of a minimum of 40 percent cover could be appropriate under general circumstances though this criteria does not take into account the affect of the high surface rock fragment cover percentages typical of this site in upland areas. Both vegetation and surficial rock fragment cover will aid in stabilizing the graded surface and reducing long-term erodibility. In the case of the graded waste rock slopes, vegetation/surficial rock fragment cover ranges from 63.0 to 73.0 percent with an average of 67.2 percent. Given that no rills or gullies were found on site and that sheet erosion was minimal following two growing seasons, it seems appropriate to conclude that this site is stable, particularly considering that the angle characterizing the graded slopes is approximately 33 percent. The constructed wetland area meets the 40 percent vegetation criterion but would none-the-less be considered stable in its own right, given the nearly level slope and wet soil conditions which render this area highly resistant to erosion.

A request to revise the applicable criteria was submitted to the Colorado Department of Public Health and Environment at the time of permit application submittal in 1996. The criterion proposed by ARCO was to achieve a minimum average cover of 50 percent by plant and rock fragment cover, combined, so long as such resulted in a stable surface. The agency personnel contacted in 1996 were receptive to this change, considering the characteristics of the project site and the materials which would form the final plant growth media, but deferred to accept such a criterion change until the time of proposed permit termination in 1998.

#### **Other Significant Hydrologic Controls**

In addition to the use of vegetative cover, other hydrologic control measures were implemented to isolate the waste rock pile from stormwater runoff/runon and the wetlands between the pile and the Dolores River. These measures included: 1) consolidation of the waste pile by removing waste rock from the adjacent wetland and from contact with the adjacent beaver pond water; 2) compaction of the top 12 inches of the surface waste rock pile; 3) construction of a permanent private access road berm between the wetlands and the toe of the consolidated and reclaimed waste rock pile, and; 4) construction of a lined (riprap, HDPE, and culvert) drainage diversion ditch to convey upland runoff away from the waste rock to the wetlands and to prevent infiltration into waste rock adjacent to the ditch.

#### **Request for Permit Termination**

ARCO requests that the criterion for successful revegetation be revised for the Santa Cruz Mine Area to that previously submitted by the Company. ARCO also requests that the Department terminate the

# Color Photo(s)

The following pages  
contain color that does  
not appear in the  
scanned images.

To view the actual images, please  
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Center at (303) 312-6473.

PHOTO LOG OF THE SANTA CRUZ MINE AREA

Photos Taken September 9, 1998

Photo #	Description
1	Near northern facility border looking south at wetland and revegetated waste rock slopes.
2	Near eastern facility border looking southwest at revegetated waste pile.





